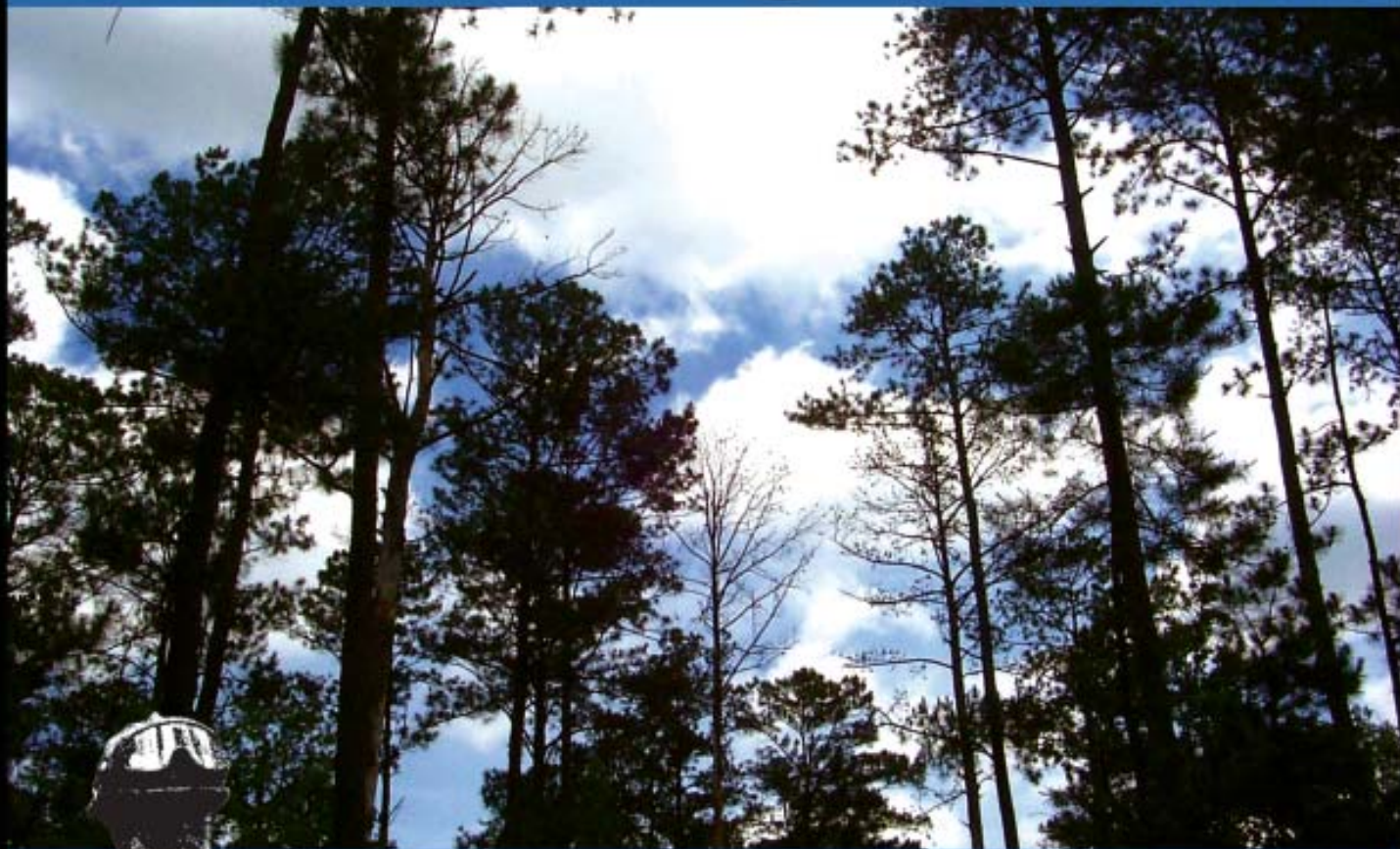


QUARTERLY RESEARCH

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REPORT



Our Mission:

Increase understanding and develop applications of disturbance to sustain the productivity and functions of Southern Ecosystems



Table of Contents

Fuel Classification for the Southern Appalachian Mountains Using Hyperspectral Image Analysis and Landscape Ecosystem Classification - **page 3**

The Role of Prescribed Burning in Longleaf Pine Restoration and Management - **page 5**

Comparison of Fire Behavior in Palmetto-Gallberry Flatwoods Following Three Fuel Reduction Methods - **page 7**

Southeastern Fire and Climate Workshop - **page 9**

Long-Range Forecasting of Fire Season Severity in Florida - **page 11**

ISSUE – Managers cannot easily access Fire Science - **page 13**

ISSUE—Fire emissions impacts air quality - **page 14**

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Project Leader's Column

Have you missed the Quarterly Science report? If you did, it wasn't because of some E-mail virus or that new spam filter you installed. The QSR has been AWOL! I am happy to report that now that Rick Reitz is onboard as our Technology Transfer Specialist, we should be able to maintain a regular publication schedule for the QSR. We've added some new items to this issue; let us (Rick or me) know how you like the Issue Highlights and the Publication Highlights. The Issues Highlights are brief overviews of resource management issues that this unit has addressed through research. Periodically we are asked to develop short statements of what we know about an issue that would help inform policymakers. Let me know if these are helpful, and of issues that you think unit scientists might address.

John Stanturf

Publications Highlights

Project scientists have published several general papers on fire and smoke. In case you haven't caught them in the Project Leader's Report or elsewhere, the citations follow. These can be downloaded from the Southern Research Station website (www.srs.fs.usda.gov) or our project website (www.srs.fs.usda.gov/disturbance).

Achtemeier, G.L., Jackson, B., and Brenner, J.D. **Problem and Nuisance Smoke**. Chapter 3.3 (pp. 41-49) in Hardy, C.C., Ottmar, R.D., Peterson, J.L., Core, J.E., Seamon, P., editors and compilers, *Smoke Management Guide for Prescribed and Wildland Fire 2001 Edition*. NFES 1279, National Wildfire Coordinating Group, Boise, ID.

Leuschen, T., Wade, D., and Seamon, P. **Fire Use Planning**. Chapter 6 (pp. 109-117) in Hardy, C.C., Ottmar, R.D., Peterson, J.L., Core, J.E., Seamon, P., editors and compilers, *Smoke Management Guide for Prescribed and Wildland Fire 2001 Edition*. NFES 1279, National Wildfire Coordinating Group, Boise, ID.

Stanturf, J.A., Wade, D.D., Waldrop, T.A., Kennard, D.K., and Achtemeier, G.L. 2002. **Fire in Southern Forest Landscapes**. Chapter 25 (pp. 607-630) In: Wear, D.M. and Greis, J.G., editors, *Southern Forest Research Assessment*. Gen. Tech. Rep. SRS-53. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Wade, D.D., Brock, B.L., Brose, P.H., Grace, J.B., Hoch, G.A., and Patterson, W.A. 2000. Chapter 4 (pp. 53-96) **Fire In Eastern Ecosystems**. In: *Wildland fire in ecosystems effects of fire on flora*. Ogden, UT. Gen. Tech. Rep. RMRS-GTR-42-vol. 2, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257p.

Fuel Classification for the Southern Appalachian Mountains Using Hyperspectral Image Analysis and Landscape Ecosystem Classification

HISTORY/BACKGROUND:

The Southern Appalachian Mountains are a diverse mosaic of plant communities. This diversity results from an almost infinite combination of soils, aspects, elevations, weather patterns, and disturbances. Historically, both lightning- and human-caused fires played a significant role in the evolution of Appalachian plant communities. However, fire has been missing for years. As a result of attempted fire exclusion over the past seventy-five years, plant community diversity has decreased and fuel loading has increased.

Although the ecological role of fire in Southern Appalachian Mountain forests was recognized, land managers used prescribed burning sparingly because it was perceived as too difficult to control on steep slopes. Since the mid-1980s, fire managers have gained skills necessary to safely apply prescribed burning, but they still lack basic planning information that is readily available in other areas of the country. For instance, we lack fuel models for Southern Appalachian Mountain forest fuel conditions. Fire managers often compensate for this lack of information by overestimating fuel loads, thereby providing a larger margin of error for potential serious fire behavior.

Detailed fuel measurements and appropriate fuel models are needed throughout the region, but collecting the needed information is costly and labor intensive. With funding from the Joint Fire Science Program and National Fire Plan, unit staff is investigating a remote sensing approach to fuel



modeling using hyperspectral images. Hyperspectral imaging is aircraft-based, using sensors that record data from many discrete bands within the visible and near-infrared regions.

RESEARCH RESULTS:

Data collection has occurred on two of the four sites of this study and constitutes about 60% of the expected data to be collected. Results, with all collected data, are expected about August 2004.

PRACTICAL APPLICATIONS:

Fuel models developed through hyperspectral imaging analysis could provide a more efficient means of fuel estimation than is currently available through ground-based measurements.

BENEFITS:

The fuels data gathered during the course of this research will add to our existing knowledge of fuel loads in Southern Appalachian Mountain forests. If the hyperspectral signatures are sufficiently accurate, they can be used to map fuels at greatly reduced costs, as compared to traditional ground-based fuel inventory methods.

COOPERATORS:

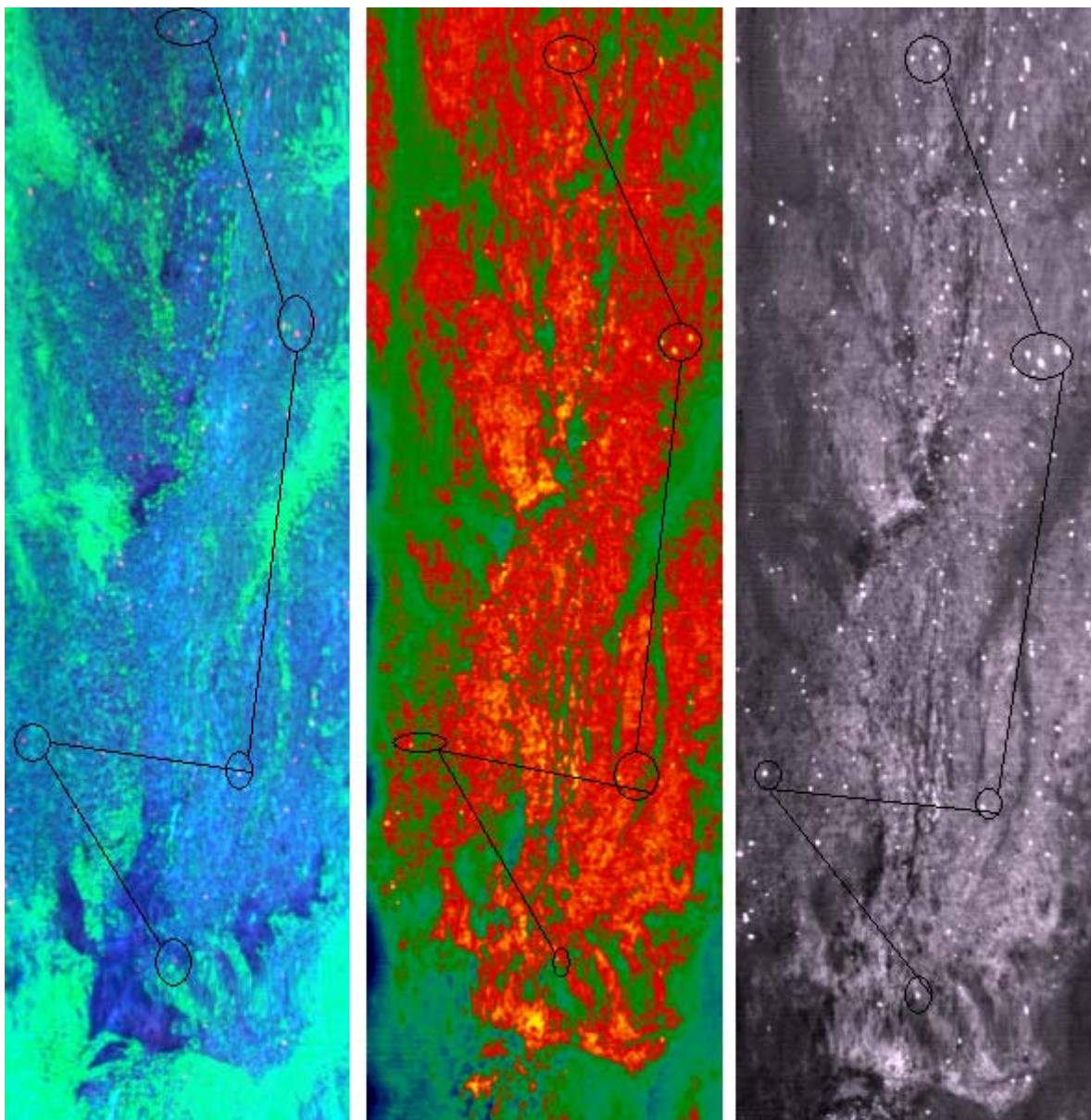
Clemson University (Department of Forestry and Natural Resources, Strom Thurmond Institute), Great Smoky Mountains National Park, USDA Forest Service.

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Hyperspectral images of the War Woman Wildlife Management Area on the Tallulah Ranger District. These images were taken 24 hours after a landscape-level prescribed burn. Circles highlight areas where the fire had been intense the previous day.



The Role of Prescribed Burning in Longleaf Pine Restoration and Management

HISTORY/BACKGROUND:

Longleaf pine (*Pinus palustris* Mill) is synonymous with Southern forests. The natural range of longleaf pine stretched from Virginia, south to Florida, then west into Texas. In a band along the northern and western fringe of its range, longleaf pine co-existed with loblolly (*Pinus taeda* L.) and shortleaf (*Pinus echinata* P. Mill.) pines, and assorted hardwoods, adding an additional 14.6 million hectares (~36 million acres) to the 24.3 million hectares (~60 Million acres) it once dominated in the southeastern United States.

Before European settlement, longleaf pine ecosystems were fire-shaped and maintained. Ignited by lightning, and augmented by Native Americans, fire intervals averaged every 2-to-8 years.

Longleaf pine now occupies less than five-percent of its original area today due to intensive exploitation since colonial times, with little regard for regeneration. In addition, many of these remnant longleaf pine stands are degraded largely due to decades of fire exclusion. Ecosystem degradation has produced significant population declines in some plants and animals adapted to these ecosystems. Realizing the importance of longleaf pine forests in the South, forest managers are committed to restoring and managing these ecosystems. Prescribed burning is a major element in these restoration efforts.

RESEARCH RESULTS:

Unit staff have studied the effects of burning natural stands and plantations of longleaf pine. The results of these studies are available in publications on a range of topics including restoration efforts with fire and

herbicides, effect of crown scorch on tree survival and growth, and the effect of periodic burning on fuels and plant communities (www.srs.fs.fed.us/osceola). Current research includes developing guidelines for reintroducing fire into stands where fire has been excluded beyond its natural range of variability and comparing those treatments for their effects on hazardous fuel reduction and ecosystem restoration.



Longleaf community restored using fire and herbicides

PRACTICAL APPLICATIONS:

To eliminate the sometimes negative effects of burning in longleaf pine ecosystems, consider these important factors:

Delay burning until seedlings are well established, usually two year following planting. Growing season burning, in the spring, stimulates growth of natural seedlings in the grass stage and should be favored by planted seedlings as well. Avoid burning when plantations are just coming out of grass stage and are most susceptible to damage and mortality from fire. Burning should be conducted prior to bud elongation to minimize risk of damage to seedlings.

Growing season burns are preferable for older (sapling-size and larger) plantations and natural uneven-aged stands.



Dormant season burns can also be used if other constraints exist (weather conditions, availability of equipment or people, etc.). A dormant season burn is preferable to no burn; in fact, some variation is desirable in season of burn. Thus, a good strategy is to conduct every third or fourth burn during the dormant season. This variation in fire return interval and month of burning is also desirable as it provides different plant species

opportunities to reproduce and grow.

Avoid burning in September. Experience has shown that the probability of significant mortality is much higher during this month, even in larger sized longleaf pine.

The risk of mortality is great in stands that have not been burned for over 10 years. This is due to an excessive buildup of litter around the base of trees. Research is ongoing to determine the best method of returning fire to these stands without excessive mortality. In the interim, however, we recommend beginning with several dormant season burns to reduce fuel loading. Apply fire only when the lower layer of duff is too wet to burn. Rapid rates of head fire spread work well in dryer sandhill sites. In flatwood sites, use head fires when conditions include cool temperatures, high humidity, and low wind speed. Reduce fuel loads by burning often. Cautious burn prescriptions are desirable; a patchy burn that protects trees is better than a complete burn that causes excessive tree mortality. The overall objective is to gradually reduce fuel loading over a cycle of several fires to keep tree mortality at an acceptable level. Once excess fuel is removed, apply growing season burns as soon as there is sufficient fuel to carry a fire.

BENEFITS:

Both longleaf pine plantations and natural stands can benefit from prescribed burning. Following guidelines, expressed in the practical application section (above), will aid managers in obtaining and maintaining healthy longleaf pine ecosystems by holding woody shrubs at an appropriate level and promoting surface forbs and grasses. Restoring the once abundant, but now absent herbaceous layer also will benefit wildlife and aesthetics. In addition, regular burning will reduce vegetative competition and recycle nutrients, thereby stimulating seedling emergence from the grass stage and increasing tree growth. Finally, regular burning will keep fuel from accumulating, thereby reducing the risk of tree and stand damage from wildland fire.

COOPERATORS:

Ocala, Osceola, Oconee, and Francis Marion National Forests; Eglin Air Force Base; and Auburn University.

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NATURAL STAND

PLANTATION

Prescribed burning longleaf pine.



Comparison of Fire Behavior in Palmetto-Gallberry Flatwoods Following Three Fuel Reduction Methods

HISTORY/BACKGROUND:

Southern forests have accumulated unprecedented levels of live and dead fuels due to decades of attempted fire exclusion. Woody shrubs and hardwoods proliferate and shade out the sun-loving herbaceous groundcover, which decreases biodiversity and eventually ecosystem health. In addition, as this woody understory of fire-volatile plants, such as palmetto, gallberry, and wax myrtle grow taller, they become a ladder, or pathway, for surface fire to climb into overstory tree species. This increase in fire intensity may result in tree damage and mortality, increase risk to wildland firefighters working to suppress the fire, and threaten structures and people.

Pine ecosystems historically dominated much of the coastal plain and were shaped by a chronic fire regime that prevented accumulations of leaf litter and woody debris. Attempted fire exclusion and landscape fragmentation disrupted the historic fire regime and increased the interval between fires, causing the humus layer to thicken under the forest floor. This thicker humus layer often prevents pine regeneration, which eventually leads to replacing the coniferous overstory with hardwoods.

Litter decomposes slowly on dry sandy sites of the coastal plain and as the interval between fires lengthens, more and more nutrients are tied up in the forest floor. Feeder roots of overstory pines soon colonize the relatively nutrient-rich humus layer. When the forest floor dries out, more is available to be consumed by wildland fire. If drought continues long enough, even the humus dries out and becomes

available fuel for wildfire. If a wildfire occurs, the feeder roots are killed, which in turn causes death of overstory trees.

Forest managers are understandably reluctant to intentionally burn stands with heavy fuel accumulations, especially near the wildland-urban interface. Unit scientists have numerous studies investigating the ramifications of unnatural fuel accumulations and how to safely rectify this situation while minimizing damage to forest resources.

RESEARCH RESULTS:

The Joint Fire Science Program and National Fire Plan are funding studies to compare effects of various fuel reduction methods on potential fire behavior. One study showed that both prescribed burning and mechanical thinning immediately reduced understory stature, which potentially lowered fire intensity.

Following this mechanical treatment with prescribed burning, live woody fuels quickly recuperated and reached dangerous levels again within three-to-four years.

Treating fuels with herbicide, however, resulted in standing dead shrubs, which exacerbated potential severe fire behavior for the next twelve-to-eighteen months, until stems fell to the ground. Because herbicide kills rootstocks, herbaceous groundcover returns and persists for at least six years. The thick forest floor is unaffected by herbicide treatment and drying may increase the likelihood that wildland fire may kill feeder roots and harm the overstory.



PRACTICAL APPLICATIONS:

A manager has limited options for reducing fuel loading. Thinning and herbicides offer only partial benefits compared to prescribed burning use. Thinning operations are not practical every three-to-four years (that's how long the thinning effect lasted); therefore a manager has the options of either prescribed burn every two-to-three years or use herbicides. While repeated herbicide applications may be effective, they can be expensive and a fuel hazard continues to exist from standing dead shrubs for up to 18 months. Even then, the specter of tree mortality from root mortality remains if herbicide alone is used. The potential to combine the long-lasting benefits of herbicide with the immediate benefits of prescribed burning to solve both the fire intensity and root mortality problems is the subject of new research.

BENEFITS:

An expanding body of knowledge shows the ecological necessity of periodic fire, but an increasing body of environmental regulations and social issues make it more difficult to use prescribed burning. Because fire and urbanization do not mix well, the use of prescribed burning in the wildland urban interface is especially difficult. Giving natural resource managers the means to reduce hazardous fuel accumulations and lengthen the interval between repeated wildland fires, without apparent negative ecological ramifications, has much appeal.

COOPERATORS:

St. Johns Water Management District, Florida Division of Forestry, Osceola National Forest, GP (Plum Creek Timber Company), and ITT Rayonier (Rayonier).

CONTACT PERSON:

Joe O'Brien (jjobrien@fs.fed.us)



1- Plowing a firebreak for experimental burns.

2- Fire herbicide treatment. Fuel loads were much lower than other treatments

3- Experimental dormant season prescribed burn.

Southeastern Fire and Climate Workshop

HISTORY/BACKGROUND:

In June 2002, the first Southeastern Fire and Climate Workshop was held in St. Petersburg, Florida. The primary goal of this workshop was initiating dialog between the land management and climate modeling communities, in hopes of improving climate products. Ultimately, these products would be tailored to specific needs, as outlined by the land managers, and prove useful in decision-making.



Opening presentations set the foundation for dialog. Six presentations, evenly divided between papers from land managers and climatologists, ranged across a variety of fire and climate topics. James O'Brien (Florida State University) presented new seasonal forecast products depicting expected Keetch-Byram Drought Index (KBDI) values for Florida with lead times out to six months. Tony Westerling (Scripps Institute of Oceanography) focused on the economic benefit of using similar climate forecasts for land management with examples from the western United States. In the last of the climate presentations, Kevin Robbins (Southern Regional Climate Center) revealed some upcoming developments in how climate data and forecasts soon may be accessed and distributed.

The three presentations from land managers presented distinct perspectives on their need for climate information. Heath Hockenberry (National Interagency Fire Center) outlined the potential benefits to government agencies from more effective use of climate information in assessing regional wildfire potential. Clay Smallwood (St. Joe Timberland Company) and James Malone (Alabama Treasure Forest Association) helped the group shift gears and look at the issue of climate information from the

perspective of large industrial land managers and the small industrial (or family) forest landowner, respectively.

RESEARCH RESULTS:

The need for a standard fire database was the most pervasive common theme. It is nearly impossible to assess regional impacts of climate on fire occurrence due to variation in the type, frequency, reliability, and availability of data from different land management agencies in the Southeast. Only a regional to national initiative, to implement a standard fire reporting database and the migration of historical data into this new format, will remove this obstacle. While the first theme (need for a standardized fire occurrence database) presents a rather daunting task, the other three themes (assessment of current climate products, interpretation of climate forecasts into recommended management decisions, and education with cross training) poses more manageable questions.

Education is perhaps the easiest to address, and this workshop was a small step in that direction. The next step is to provide cross training: climatologists need to learn about fire prediction tools (particularly the National Fire Danger Rating System and Fire Family Plus) and land managers need to learn about climatology. Many land managers already have a good understanding of meteorology, but they need to better understand the difference between meteorology and climatology.

Education and research will help in dealing with the two other themes. The current climate forecasts provided by the National Climate Prediction Center (CPC) are not easy for the non-climatologist to interpret, and conveying a sense of their accuracy and

reliability is even more difficult. CPC data need to be interpreted and put into information products that are useful to land managers. This interpretive layer must include an indication of reliability (forecast skill and confidence).

PRACTICAL APPLICATIONS:

The various Geographic Area Coordination Centers (GACCs) around the country have begun holding annual pre-fire season meetings to generate a seasonal assessment of potential fire conditions. These meetings combine land managers and climatologists. The Fire and Climate Workshop was a first step in opening a dialog between these groups. This dialog has continued; the improved cooperation and understanding has led to the development of operational fire season assessments where fuels experts and climatologists together produce a forecast that is tailored to the needs of land managers

BENEFITS:

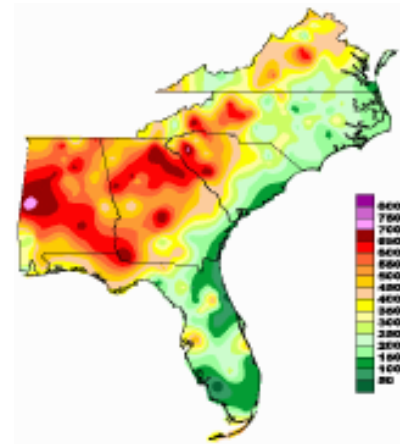
Climate forecasting capabilities will continue to improve, much as weather forecasting skill has improved. However, the full benefits of improvements in climate forecasts will not be realized unless the resulting products address the needs of various end-user communities, such as land managers. All would benefit if the action items developed by the workshops evolve into proposals to remove the barriers currently limiting the usefulness of climate information in land management decision-making.

COOPERATORS:

Florida State University, Florida Division of Forestry

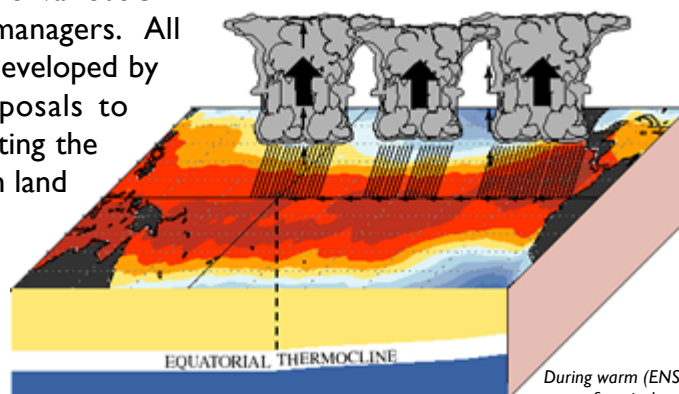
CONTACT PERSON:

Scott Goodrick (sgoodrick@fs.fed.us)



Example of KBDI mapping for Southeastern US

March - May ENSO Conditions



During warm (ENSO) episodes the normal patterns of tropical precipitation and atmospheric circulation become disrupted. The abnormally warm waters in the equatorial central and eastern Pacific give rise to enhanced cloudiness and rainfall in that region, especially during the boreal winter and spring seasons.

Long-Range Forecasting of Fire Season Severity in Florida

HISTORY/BACKGROUND:

Recent advances in climate prediction have come from a greater understanding of natural oscillations in the global ocean-atmosphere system. Most notable is the interannual variability of ENSO (El Niño-Southern Oscillation), which causes regional shifts in seasonal temperature and precipitation across North America, especially during winter. The relationship between ENSO and seasonal precipitation and temperature patterns in North America is now well established and is used as a tool by the Climate Prediction Center to forecast season rainfall and temperature trends up to a year in advance.

Given that wildfire activity is intimately linked with temperature and precipitation, it naturally follows that the interannual drivers of our climate would also have an influence on wildfire activity. Several studies have shown the connection between ENSO and wildfire activity, both in Florida and the western United States.

While the ENSO relationship to wildfire activity is important, and lends a measure of predictability to forecasting the severity of an upcoming wildfire season, it is only one of several indicators of fire season severity. Land management activities such as fuel mitigation, fire prevention, and fire suppression activities often reduce wildland fire occurrence and severity; but arson may have the opposite effect. Therefore, quantitative forecasting of wildland fire season severity, based upon ENSO alone, will be very difficult.

RESEARCH RESULTS:

El Niño and La Niña dramatically affect seasonal rainfall and temperature patterns in Florida. El Niño brings excessive winter rainfall, up to 40% above normal for the months of December through March. The effect of this winter rainfall on wildfires is dramatic, with from 25% to 100% fewer acres prescribed burned over most counties in the winter months.

El Niño brings a subtle shift in rainfall to central and north Florida in the early summer, with conditions actually drier than normal. This shift seems subtle when looking at rainfall alone. But rainfall deficits at this time of year, when temperatures and evapotranspiration rates are high, can quickly dry vegetation and fuel. Furthermore, the plentiful winter and spring rains enhance vegetation growth, providing more fuel than in normal (neutral) conditions. This early season dryness, caused by El Niño, was particularly damaging in 1998 when north Florida had one of its worst bouts of wildfire.

La Niña has a converse effect on rainfall in Florida. The cold season months of November through April can expect 20% to 40% less rainfall than normal during the La Niña phase of ENSO. This dryness does not affect wildland fire activity until March, due to the cumulative impacts of several months of rainfall deficits. Peninsular counties begin to experience increases in acreage burned, with the most dramatic increases (100% to 1000%) in south Florida. The increase in wildfire activity then spreads up the peninsula in April and lasts the remainder of the fire season. The Panhandle counties do not seem to be influenced as much by the dry La Niña winters because they are exposed to more winter precipitation from fronts and cyclones than the peninsular counties.

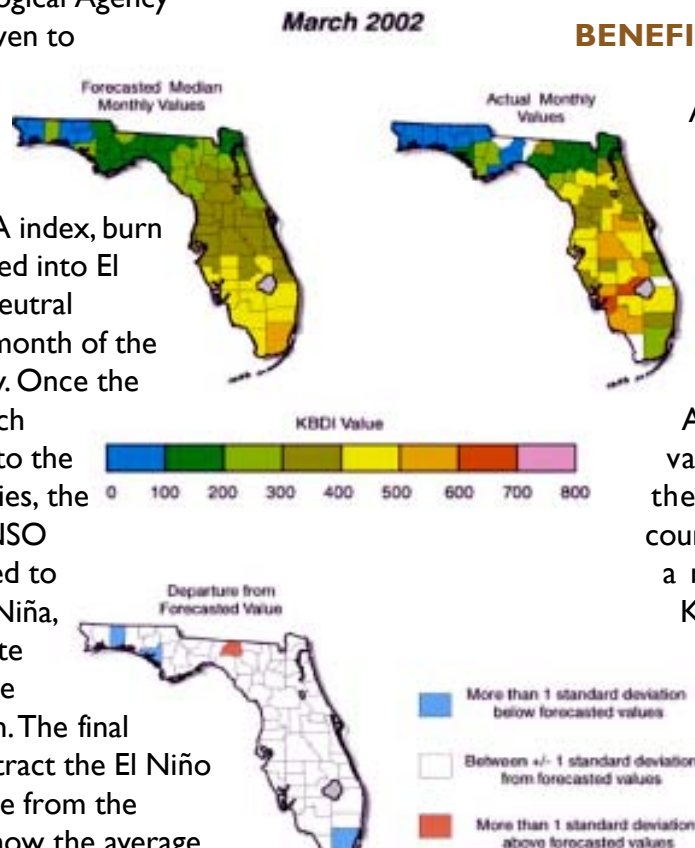
In all three ENSO phases (El Niño, La Niña, and neutral), summer rainy season is well underway by July and the threat of wildland fires is greatly reduced. Any shifts in wildland fire activity due to ENSO are small and the acreage burned is much less than during the traditional fire season.

The Japan Meteorological Agency (JMA) index has proven to be the most reliable and consistent measure of the historical state of ENSO. Using the JMA index, burn statistics can be sorted into El Niño, La Niña, and neutral categories for each month of the fire season by county. Once the burn statistics for each county are sorted into the three ENSO categories, the statistics for each ENSO phase can be averaged to form an El Niño, La Niña, and neutral composite for each month of the upcoming fire season. The final step is to simply subtract the El Niño or La Niña composite from the neutral average to show the average impacts of the different ENSO phases. The departures from normal (neutral) can then be displayed in map form as the percentage change in acreage burned for the six months of fire season.

PRACTICAL APPLICATIONS:

In 2002, an experimental six-month probabilistic forecast of the Keetch-Byram Drought Index (KBDI) was produced for Florida that showed very promising results. A revised methodology is used to

forecast KBDI over larger portion of the southeastern United States (Georgia and Alabama). Recently, information gained through developing these products has been incorporated into the fire season assessments produced for the Southern Area Coordination Center (SACC) by an interagency group of fire behavior and climate experts.



BENEFITS:

A data set with over fifty years of historical daily weather observations (temperature and precipitation) has been assembled from National Weather Service (NWS) cooperative observer stations across the state of Florida. A continuous record of KBDI values has been computed from these weather observations on a county-by-county basis. By developing a relationship between ENSO and KBDI, probabilistic forecasts of the KBDI based on current/expected ENSO conditions are possible. The KBDI is known to be an indicator of fire potential in the southeast and by putting the climate forecast into this context, land managers are better able to make use of the climate information in their business decisions.

COOPERATORS:

Florida Climate Center, The Florida State University, Florida Division of Forestry.

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ISSUE – MANAGERS CANNOT EASILY ACCESS FIRE SCIENCE

Issue: The gap between research and application limits the use of best available fire science by managers.

Current research results about fire can be difficult to find.

- Research results are published in technical reports, books, and journals.
- Managers often have difficulty getting to libraries with technical information
- Agencies and landowners cannot afford subscriptions to all the technical journals that carry fire science information
- Managers will make better decisions if best available science is available at their desktop

Scientific information is typically fragmented, scattered, and narrowly applicable to regional or local conditions.

- Managers need research information to be synthesized into best available science
- New results need to be easily integrated into management practices
- Southern conditions for wildfire and prescribed burning differ greatly from other regions of the country due to greater productivity and humid climate

The Encyclopedia of Southern Fire Science uses Internet technology to deliver best available fire science to land managers.

- Internet publication of science syntheses are free and readily available
- Managers will have the best available science at their fingertips
- Internet technology allows information to be easily updated based on new research results
- Peer review of entries in the Encyclopedia ensures quality control and maintains credibility



The new *Encyclopedia of Southern Fire Science* will build upon the concepts and tools developed for a prototype hypertext encyclopedia, *The Encyclopedia of Southern Appalachian Forest Ecosystems (ESAFE)*, also available at: www.forestencyclopedia.net. Currently ESAFE includes 1100 pages of content, 300 tables and figures, 3000 internal hyperlinks, and 1800 external hyperlinks.

Approved authors can log-on to the Encyclopedia CMS on-line to access their own **personal desktop**, such as the one here. Using their personal desktop, authors can compose content, add tables and images, insert hyperlinks, and add references.

ISSUE—FIRE EMISSIONS IMPACTS AIR QUALITY

Issue: Regulatory policies must be based on best available science of how emissions from fires impact regional haze, smog, and visibility.

Wildland fire emissions produce regulated air pollutants and greenhouse gases.

- Biomass burning releases large amounts of particulate matter (PM), CO, SO₂, NO_x, and volatile organic compounds (VOC) as well as CO₂, a prominent greenhouse gas
- Wildland fire emissions contain criteria air pollutants subject to the National Ambient Air Quality Standards (NAAQS) established by the EPA
- EPA recently established air quality standards for PM_{2.5} (particulate matter less than 2.5 microns) and revised standards for ground level O₃ (ozone) and PM₁₀ (particulate matter less than 10 microns) as an effort to reduce regional haze and smog, and to improve visibility

Available tools for estimating emissions and their effects are inadequate

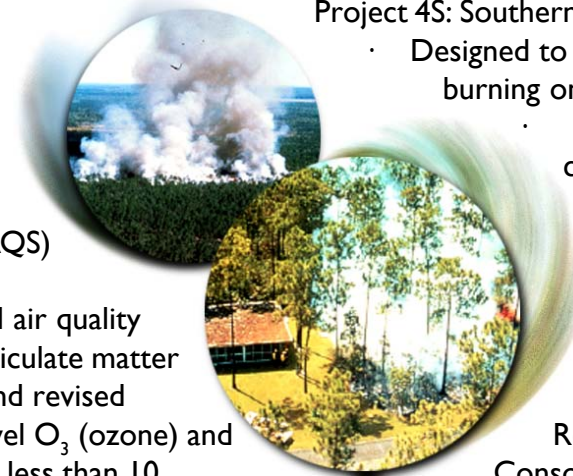
- Highly complex models are used but must be improved and adapted to better represent wildland fires as an emission source
- Data are needed in near-real time on where burning occurs, area burned, time and duration of burn, firing technique, fuel type, amount, and moisture, and high-resolution weather data out to 72 hours
- An integrated framework is needed to combine models and data streams

Data on burning is not uniformly available in the southern states

- Forest land in the South is mostly privately owned
- Ownership size is much smaller than in the West
- Permitting and reporting systems vary greatly among the states
- Fuels data can be obtained from the National Fire Danger Rating System fuels database and from satellite data

Project 4S: Southern Smoke Simulation System

- Designed to predict impacts of wildland burning on regional air quality
 - Integrates models for combustion, emissions, vertical transport of smoke, smoke dispersion, atmospheric chemistry, and local smoke models
 - Works under the umbrella of the Southern High Resolution Modeling Consortium (SHRMC)
 - High-resolution weather data provided by SHRMC



What More Is Needed?

- System to acquire near real-time burning data
- Stable funding from diverse sources for SHRMC operational services and research
- Improved models of fire behavior, smoke movement, and air chemistry
- Better understanding of how climate influences fire and the impacts of burning on climate and air quality